



## **Limestone assimilation: an important non magmatic source of volcanic CO<sub>2</sub>**

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Understanding volatile emissions in volcanic areas is necessary to quantify the volcanic contribution to Earth's degassing into the atmosphere. Moreover, volatile emissions are also useful indicators of the physical and chemical status of the magma at depth. Volatile fluxes measured at surface can indeed be bridged to the magma dynamic in terms of cooling and/or ascent, with the help of volatile solubility laws. However, massive CO<sub>2</sub> fluxes around several volcanic centres can difficultly be explained considering the relatively low CO<sub>2</sub> solubilities in silicate melts at pressures of volcanological interest. Our study focuses on limestone assimilation by magma at shallow depth (6-15 km) and its possible effect on volatile emissions at surface. We performed HP-HT experiments to simulate the assimilation of carbonates by basaltic magmas. Here we present an application of this process to the volcanic systems of Central-Southern Italy. Mt. Vesuvius and several volcanoes in Central-Southern Italy are emplaced on carbonate-dominated sedimentary sequences 6 to 20 km thick. They produce singular lavas, globally potassium rich but with marked changes in composition slightly to highly silica-undersaturated. Moreover, these volcanic areas are characterized by large CO<sub>2</sub> fluxes of deep provenance, largely exceeding possible contributions of magmatic origin. Our experiments clearly reproduce the main chemical trends observed in magmas emitted at Mt. Vesuvius over the last 25,000 years. Our data strongly suggest that massive limestone assimilation (10 to 15wt%) by a basaltic magma, currently occurs at crustal depth (6-12 km) below Mt. Vesuvius. We calculate that this process releases an amount of CO<sub>2</sub> similar to measured fluxes at Mt. Vesuvius. Limestone assimilation most likely operates at variable extent in other volcanic systems of Central-Southern Italy, being therefore the major source of the CO<sub>2</sub> diffusely degassed in this area. Our results imply that volatile emissions cannot solely

be interpreted using solubility laws in magmas and that a complete knowledge of the petrological processes operating at depth is actually essential. For example, a minor assimilation of ~1wt% limestone by a basaltic magma would liberate a quantity of CO<sub>2</sub> exceeding its solubility at 200MPa. Such a low assimilation degree of volatile-rich components is most likely the source of anomalously high volatile fluxes measured in several famous volcanoes (e.g. Popocatépetl, Etna). Given the widespread presence of sedimentary carbonate in the upper crust, this process is likely to occur and to have occurred in other volcanic areas and must be taken into account for the estimation of the total amount of CO<sub>2</sub> injected into the atmosphere by volcanoes.